TITLE OF INVENTION

Intensity Variation Device for Training Animals

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Not Applicable

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable

BACKGROUND OF THE INVENTION

1. Field of Invention

[0003] This invention pertains to an apparatus for varying the intensity of stimulation applied during animal training. More particularly, this invention pertains to varying the intensity of stimulation applied to an animal wearing a collar having an attached receiver. The intensity of the stimulation is controlled by varying the current to a pulse transformer.

2. Description of the Related Art

[0004] Radio controlled training collars are known for conditioning the behavior of an animal. A transmitter, commonly handheld, is controlled by a trainer. The collar is worn by an animal and includes a receiver that triggers an electrical circuit that applies electrical stimulation to the animal through electrodes in contact with the animal. To train the animal, the electrical stimulation must be sufficient to gain the animal's attention without injuring the animal. Further, some training protocols requires that the animal receive different stimulation based upon the animal's behavior.

[0005] Various methods are known for varying the stimulation applied to an animal through a training collar. For example, United States Patent 5,666,908, titled "Animal Training Device," issued to So on September 16, 1997, discloses an animal training device that applies different levels of electrical stimulation to an

animal by varying a pulse width. The electrical stimulation is generated by applying a series of pulses to a switch connected to a transformer, which has its secondary windings connected to electrodes that contact the animal. The pulses have a constant voltage level at a fixed frequency; however, the pulse widths vary based on the desired stimulation to be applied. The transformer secondary voltage is directly related to the pulse width, accordingly, the electrical stimulation applied to the animal varies as the voltage varies. The lowest level of stimulation is produced with narrow pulse widths resulting in a lower voltage of electrical stimulation applied to the animal. The highest level of stimulation is produced with wide pulse widths resulting in higher voltage of electrical stimulation.

[0006] Another example is the device disclosed in United States Patent Number 4,802,482, titled " Method and Apparatus for Remote Control of Animal Training Stimulus," issued to Gonda, et al., on February 7, 1989. The Gonda device uses trains of pulses applied to the switch connected to the transformer. The Gonda device varies the stimulation intensity by varying the frequency of the pulses in the pulse train. The pulse train includes pulses having a fixed voltage and pulse width; however, the period between pulses is variable. The electrical stimulation applied to the animal is at a fixed voltage. The level of stimulation varies with the number of electrical stimulation signals applied to the animal per second. The lowest level of stimulation is produced by a pulse train with a low pulse frequency resulting in fewer electrical stimulation shocks per second. The highest level of stimulation is produced by a pulse train having a high pulse frequency resulting in more electrical stimulation shocks per second. The duration of the stimulation to the animal is controlled by the operator of the Gonda device.

[0007] A still another example is the device disclosed in United States Patent Number 5,054,428, titled "Method and Apparatus for Remote Conditioned Cue Control of Animal Training Stimulus," issued to Farkus on October 8, 1991. The Farkus device varies the stimulation intensity applied to the animal by varying the length of the pulse train applied to the switch connected to the transformer. The pulse train includes pulses having a fixed voltage and pulse width, and the pulses have a fixed frequency. The electrical stimulation applied to the animal is at a fixed voltage. The level of stimulation varies with the duration of the stimulation to

the animal. The lowest level of stimulation is produced with a pulse train having a single pulse and a short duration. The highest level of stimulation is produced by a pulse train that includes approximately 64 pulses, which results in a longer duration stimulation being applied to the animal.

BRIEF SUMMARY OF THE INVENTION

[0008] According to one embodiment of the present invention, an animal training device is provided. The device includes a transmitter unit and a receiver unit, which is attached to a collar. The device provides a stimulus to an animal based on the actions of a trainer. The stimulus is either audible, such as a beep, or electrical, such as a shock applied to an external area of the animal. The electrical stimulation has variable levels determined by the current applied to a pulse transformer transformer, which is connected to electrodes.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0009] The above-mentioned features of the invention will become more clearly understood from the following detailed description of the invention read together with the drawings in which:

Figure 1 is a pictorial view of a transmitter unit and a receiver unit worn by an animal;

Figure 2 is a block diagram of one embodiment of the transmitter unit;

Figure 3 is a block diagram of one embodiment of the receiver unit;

Figure 4 is a partial schematic diagram showing one embodiment of a portion of the receiver unit;

Figure 5 is timing diagram for a low stimulation level;

Figure 6 is a timing diagram for a high stimulation level; and

Figure 7 is a flow diagram of one embodiment of the processor functions.

DETAILED DESCRIPTION OF THE INVENTION

[0010] An apparatus for an animal training device is disclosed. The device is shown generally as **10** on the drawings. The apparatus provides stimulation, either audible or electrical, to the animal to promote or discourage specific behavior of the animal.

[0011] Figure 1 illustrates the animal training device **10**, which includes a transmitter unit **102** and a receiver unit **104** attached to a collar **106** worn by an animal **108**. The transmitter unit **102** includes an antenna **118**. Those skilled in the art will recognize that the antenna **118** can be an external antenna as shown in Figure 1 or an antenna internal to the housing of the transmitter unit **102** without departing from the spirit and scope of the present invention. The transmitter unit **102** includes a pushbutton switch **112** for producing a tone at the receiver unit **104**. The transmitter unit **102** also includes a pushbutton switch **114** for producing a corrective stimulation at the receiver unit **104**. The transmitter unit **102** also includes a selector switch, or a stimulation level switch, **116** for selecting the level of correction. Those skilled in the art will recognize that the stimulation level switch **116** can be a rotary switch or other type of selector switch without departing from the spirit and scope of the present invention.

[0012] The receiver unit **104** is attached to a collar **106** that is worn about the neck of an animal **108**. Those skilled in the art will recognize that the collar **106** can be worn about other parts of the animal's body without departing from the spirit and scope of the present invention.

[0013] Figure 2 illustrates a block diagram of the transmitter unit **102**. The tone switch **112**, the correction switch **114**, and the stimulation level switch **116** provide inputs to a processor **202**. The processor **202** produces a signal that is sent through the transmitter **204** to the antenna **118**.

[0014] In one embodiment, pressing either the tone switch **112** or the correction switch **114** initiates the generation of an 18 bit data stream by the processor **306**. The data stream generated by the processor **306** is sent to the transmitter **204** and, ultimately, the receiver unit **104**. The 18 bit data stream

includes 1 bit for the pre-amble or sync, 8 bits for an identification code, 1 bit to identify that data stream is a test or identification code, 1 bit to identify dog one or dog 2, 3 bits to identify the mode or stimulation type, that is, whether the stimulation is a beep (tone) or a shock (correction), and 4 bits for the stimulation level. The transmitter unit **102** is matched to the receiver unit **104** through the use of the identification code. Unless the identification code sent by the transmitter unit **102** matches the identification code stored in the receiver unit **104**, the receiver unit **104** will not respond. The mode or stimulation type code, which identifies whether the stimulation is a tone or correction, is based on which switch, the tone switch **112** or the correction switch **114**, is actuated. The final 4 bits are derived from the position of the stimulation level switch **116**. In one embodiment, the stimulation level switch **116** is a 10-position rotary switch, with each position representing a different level of corrective stimulation. Those skilled in the art will recognize that the stimulation level switch **116** can have as many positions as stimulation levels desired without departing from the spirit and scope of the present invention.

[0015] Figure 3 illustrates a block diagram of the receiver unit **104**. A receiving antenna **302** is connected to a receiver **304**, which detects the signal from the transmitting unit **102** and outputs the 18 bit data stream as the received coded signal **322**. The receiver **304** is connected to a processor **306**, which acts upon the data stream. The processor **306** is connected to a switch array **308**, which controls the transformer **310** connected to the electrodes **312**. The processor **306** is also connected to a speaker **314**, which provides a tone to the animal. The 18 bit data stream is detected by the receiver **304** and is passed to the processor **306** as a received signal **322**. The processor decodes the received signal, or data stream, **322** and controls the switch array **308** and the speaker **314**, as appropriate. In one embodiment, the speaker, or sound generating device, **314** includes an amplifier connected to a speaker or other sound producing device. The received signal **322** represents a request message from the transmitter unit **102**, and the request message contains, in one embodiment, an identification code, a stimulation type code, and a stimulation level. In another embodiment, the received signal, or request message, **322** contains a test code that flags that the

request message **322** is a test signal, in which case the processor **306** executes software that performs the test functions.

[0016] Figure 4 is a schematic diagram of a portion of the receiver unit **104** showing only the relationship of the connections between the processor **306**, the switch array **308**, and the transformer **310**. The processor **306** has four output connections **RA0**, **RA1**, **RA2**, **RA3** connected to resistors **R1**, **R2**, **R3**, **R4** and the gates of single N-channel HEXFET power MOSFETs **Q1**, **Q2**, **Q3**, **Q4**, which is the switch array **308** illustrated in Figure 3. The drain of the MOSFETs **Q1**, **Q2**, **Q3**, **Q4** are connected to the primary of the transformer **310** through output resistors **R11**, **R12**, **R13**, **R14**, which have varying resistance values. The other end of the primary of the transformer **310** is connected to the power supply **V+**.

[0017] In one embodiment, the processor **306** is a Microchip part number PIC16CE626, which is a CMOS OTP-based 8-bit microcontroller. In one embodiment, the MOSFETs **Q1**, **Q2**, **Q3**, **Q4** are International Rectifier part number IRF7341 dual N-channel MOSFETs. Those skilled in the art will recognize that other processors and MOSFETs can be used without departing from the scope and spirit of the present invention.

[0018] The output connections **RA0**, **RA1**, **RA2**, **RA3** of the controller **306** are bi-directional input/output (I/O) ports. The output connections **RA0**, **RA1**, **RA2**, **RA3** are controlled to be in one of two states: ground or Vdd, which is the positive power supply voltage.

[0019] Figures 5 and 6 are timing diagrams illustrating the waveforms and their timing for the stimulation signals. The processor **306** produces, via the outputs **RA0**, **RA1**, **RA2**, **RA3**, an input pulse stream **512**, **612** that provides the inputs to the gates of the MOSFETs **Q1**, **Q2**, **Q3**, **Q4**. The input pulse streams **512**, **612** have a fixed pulse width **502**, a fixed pulse frequency (illustrated by the pulse width **502** and the separation **504** between pulses **512**, **612**), and a fixed amplitude, or voltage level, **506**, **606**. The input pulse stream **512**, **612** is acted upon by the switch array **308** and transformer **310** to produce an output pulse stream **522**, **622** having a fixed period **502** plus **504** or frequency. The amplitude,

or voltage level, **508**, **608** of the output pulse stream **522**, **622** varies in relation to the selected stimulation level.

[0020] The four output connections **RA0**, **RA1**, **RA2**, **RA3** each output a pulse stream with each pulse having a constant width **502**, frequency, and amplitude **506**, **606**. Each output connection **RA0**, **RA1**, **RA2**, **RA3** is connected to a resistor **R1**, **R2**, **R3**, **R4**, which is respectively connected to a MOSFET **Q1**, **Q2**, **Q3**, **Q4**. The outputs of the MOSFETs **Q1**, **Q2**, **Q3**, **Q4** are each connected, through a resistor **R11**, **R12**, **R13**, **R14** to the pulse transformer **310**. As each MOSFET **Q1**, **Q2**, **Q3**, **Q4** is turned on by having a pulse applied **514**, **614**, the MOSFET output resistor **R11**, **R12**, **R13**, **R14** limits the current that can flow through the pulse transformer **310**. Each of the output resistors **R11**, **R12**, **R13**, **R14** has a different resistance value. In one embodiment the resistors **R11**, **R12**, **R13**, **R14** are 2.7 ohms, 6.8 ohms, 15 ohms, and 27 ohms, respectively. Table 1 shows the output voltage for these resistance values as the MOSFETs **Q1**, **Q2**, **Q3**, **Q4** are switched on singly and in combination. The "X" in the table indicates that the MOSFET **Q1**, **Q2**, **Q3**, **Q4** having that output resistance value is switched on, generating the voltage listed in the first column at the output of the pulse transformer **310**. Each of the ten voltage levels listed corresponds to one of the positions of the 10 position stimulation level switch **116**.

Output V ltage 508, 608				
425 V	X			
810 V		X		
1250 V	X	X		
1700 V			X	
2100 V	X		X	
2400 V		X	X	
2750 V	X	X	X	
3750 V				X
4500 V			X	X
5200 V	X	X	X	X
Output Resistance: R11 to R14	**27Ω**	**15Ω**	**6.8Ω**	**2.7Ω**

Table 1

[0021] With respect to Figure 5, input signal **512** is the waveform for a low stimulation level signal from one of the outputs **RA0**, **RA1**, **RA2**, **RA3** applied to the associated input resistor **R1**, **R2**, **R3**, **R4** and entering the gate of the associated MOSFET **Q1**, **Q2**, **Q3**, **Q4**. The input signal **512** is a square wave signal with pulses **514** that have a fixed amplitude, or voltage level, **506**, a fixed width **502**, and a fixed period **504** between pulses.

[0022] The output signal **522** is the waveform of the signal produced at the output of the transformer **310** corresponding to the input signal **512**. The secondary of the transformer **310** produces, or generates, an output signal **514**, which is a pulse stream that corresponds to the input signal **512**. When the input signal **512** transitions from the pulse **514** to the period **504** between pulses, an output pulse **524** is generated, and the output pulse **524** has a voltage level **508** corresponding to the current flowing through the primary of the pulse transformer **310** from the pulse **514**.

[0023] With respect to Figure 6, input signal **512** is the waveform for a stimulation level signal from one of the outputs **RA0**, **RA1**, **RA2**, **RA3** applied to the associated input resistor **R1**, **R2**, **R3**, **R4** and entering the gate of the

associated MOSFET **Q1**, **Q2**, **Q3**, **Q4** and the input signal **612** is the waveform for a stimulation level signal from another one of the outputs **RA0**, **RA1**, **RA2**, **RA3** applied to the associated input resistor **R1**, **R2**, **R3**, **R4** and entering the gate of the associated MOSFET **Q1**, **Q2**, **Q3**, **Q4**. As in Figure 5, the output signal **522** is the waveform of the signal produced at the output of the transformer **310** corresponding to the input signal **512**. However, the amplitude of the output pulses **624** is increased over the amplitude of the output pulses **524** of Figure 5 because the current flowing through the pulse transformer **310** for the combined two preceding pulses **514**, **614** is greater than that illustrated in Figure 5. Accordingly, as illustrated in Figures 5 and 6 and in Table 1, the output signal **522**, **622** voltage level **508**, **608** is related to the number of input signal pulses **514**, **614** that cause the associated MOSFETs **Q1**, **Q2**, **Q3**, **Q4** to switch on and apply current to the primary of the pulse transformer **310**.

[0024] The input signals **512**, **612** are controlled by the processor **306**, which includes software for forming the data streams at the outputs **RA0**, **RA1**, **RA2**, **RA3**. The processor **306** includes software and routines for decoding the signal **322** received from the transmitting unit **102**. Included in the coded signal **322** is a stimulation level code, which is used by the processor **306** to determine the setting of the outputs **RA0**, **RA1**, **RA2**, **RA3**. The outputs **RA0**, **RA1**, **RA2**, **RA3** are controlled by the processor **306** to produce the input signal **512**, **612** by alternating the state of the outputs **RA0**, **RA1**, **RA2**, **RA3** between the pulse **514**, **614** on and off states, with the on state being held for a period equal to the pulse width time **502** and the off state being held for a period equal to the period **504** between pulses **514**, **614**. The number of the outputs **RA0**, **RA1**, **RA2**, **RA3** which produce the input signals **512**, **612** determines the output signal **522**, **622** voltage level **508**, **608**.

[0025] Figure 7 illustrates the various functions performed by one embodiment of the processor **306**. The signals **322** from the receiver **304** are monitored **702**. When a signal **322** is received, the signal **322** is checked to verify whether it contains a correct identification (ID) code **704**. If the ID code matches that stored in the processor **306**, the monitored signal **322** is then checked to see if the stimulation is a beep **708**. If the ID code does not match, the signal **322** is

ignored **706** and the processor **306** monitors the output of the receiver **304** for another signal **322**. If the signal **322** indicates that a beep is desired, the processor **306** generates a beep **710**, which operates the speaker **314**. Generating the beep **710** is accomplished by generating a control signal that is routed to an output of the processor **306** that is connected to a sound generating device **314**.

[0026] If a beep is not desired, the monitored signal **322** is then checked to see if the stimulation is a shock **712**. If the signal **322** does not indicate a shock is desired, the processor **306** loops back to monitor the output of the receiver **306**. If a shock is desired, the signal **322** is decoded to generate the stimulation level **714**. The processor **306** then generates stimulation level **714** by generating one or more pulse streams that are applied to the appropriate output connections **RA0**, **RA1**, **RA2**, **RA3** of the controller **306**. The one or more pulse streams cause the MOSFETs **Q1**, **Q2**, **Q3**, **Q4** to switch on, as appropriate, and cause a current to flow through the pulse transformer **310** such that the output pulse intensity corresponds to the selected stimulation level. The combination of MOSFETs **Q1**, **Q2**, **Q3**, **Q4** switched on by the processor **306** determines the output pulse intensity.

[0027] The length of the signal **322**, which determines the stimulation period, is controlled by the operator operating the correction switch **114** and the processor **306**. In one embodiment, the processor **306** includes a routine for limiting the duration of the signal **322**. In one embodiment, this duration is a maximum of 8 seconds for all stimulation levels. In another embodiment, the operator can select a shorter stimulation period, or length of the signal **322**, by releasing the correction switch **114** before the maximum duration time has been reached. For example, if the operator desires a one second stimulation, the operator depresses the correction switch **114** for a one second period and then releases the switch **114**, which terminates the signal **322**.

[0028] The processor **306**, in other embodiments, includes a routine for performing the function of verifying the validity of the received signal **322**. As described above, in one embodiment the transmitter unit **102** generates an 18 bit

data stream. In another embodiment, the processor **306** verifies that the received signal **322** contains exactly 18 bits of data.

[0029] In one embodiment, each of the functions identified in Figure 7 are performed by one or more software routines run by the processor **306**. In another embodiment, one or more of the functions identified in Figure 7 are performed by hardware and the remainder of the functions are performed by one or more software routines run by the processor **306**.

[0030] The processor **306** includes a memory medium that stores software, or routines, that the processor **306** executes. These routines can be discrete units of code or interrelated among themselves. Those skilled in the art will recognize that the various functions can be implemented as individual routines, or code snippets, or in various groupings without departing from the spirit and scope of the present invention. As used herein, software and routines are synonymous. However, in general, a routine refers to code that performs a specified function, whereas software is a more general term that may include more than one routine or perform more than one function.

[0031] As used herein, the processor **306** should be broadly construed to mean any computer or component thereof that executes software. The processor **306** includes a memory medium that stores software, a processing unit that executes the software, and input/output (I/O) units for communicating with external devices. Those skilled in the art will recognize that the memory medium associated with the processor **306** can be either internal or external to the processing unit of the processor without departing from the scope and spirit of the present invention.

[0032] The function of receiving the coded signal **322** is performed by the receiver **304**. The function of decoding the coded signal **322** is performed by the processor **306**. The function of producing the electrical stimulation is performed, in one embodiment, by the processor **306** outputting at least one pulse stream **512**, **612** to a switch array **308**, which produces a current through the pulse transformer **310** that is related to the requested stimulation level. The function of producing a beep is performed by the processor **306** and the speaker **314**.

[0033] From the foregoing description, it will be recognized by those skilled in the art that an apparatus for an animal training device is provided. The apparatus uses a plurality of pulse streams to control the current through a pulse transformer which sets the electrical stimulation applied to an animal for training. Also, the apparatus uses a processor to decode the signal from the transmitting unit and to control the stimulation type and level.

[0034] While the present invention has been illustrated by description of several embodiments and while the illustrative embodiments have been described in considerable detail, it is not the intention of the applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. The invention in its broader aspects is therefore not limited to the specific details, representative apparatus and methods, and illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of applicant's general inventive concept.